# Earth Systems Standard V, Objective 2

Title: Greenhouse Effect and Surface Radiation

**Description:** Students will design a controlled experiment to demonstrate the greenhouse effect and the effect of different surfaces on light reflection.

**Materials:** 1 large beaker and one plate per group, thermometers or Intel temperature probes (2 per student group) different substances for the bottom of the beaker and plate such as dirt, water, white paper, snow, black paper, grass or leaves, rocks etc., light sources (4-5 per classroom) student page (see below)

Time Needed: 70 minutes

**Background Knowledge:** The plastic wrap used in this experiment to model the action of greenhouse gases is limited. It should be explained to students that individual molecules of C0<sub>2</sub>, methane and water vapor act to reflect heat back to Earth instead of allowing it to immediately radiate back out into space. The plastic wrap, being a solid is a poor model but effective for this experiment. Students should be able to read a thermometer or use their Intel probe.

#### **Procedures:**

## Day 1 (20 minutes)

- 1. Read the introduction on the student page with students. Show students the materials and read the procedures with them. Have students look carefully at the drawings.
- 2. Remind student that the reason for the control is to have a way to compare their test results.
- 3. Give students time to work in their groups and decide on what substance they want to place in the bottom of their beakers. Have a group member come to the board and write the groups' choice on it. No two groups can have the same one.
- 4. Groups may chose to place substances in their beaker that you do not provide. Give them the opportunity to bring them in for the experiment on day 2.
- 5. Have students write a hypothesis based on the list of substances on the board. Have them predict which beaker will heat the most and the least.

# Day 2 (50 minutes)

- 1. Have students begin their experiment and place it under the light source. Remind them to keep the beaker and plate about 30 cm from the light.
- 2. Allow 10 minutes for students to gather and record data.
- 3. Have students report to the class by group with their findings. Record their findings on the board or an overhead as they present them. Ex.:

Surface	Plate A(no plastic wrap)	Beaker B (with plastic wrap)	Difference (B- A=)
Water			
Dirt			

4. Have each group explain why they think they got their results.

# **Scoring Guide**

- Student participates and contributes to activity......4
   Student collects data and graphs accurately......4
- 3. Student correctly answers analysis questions......4

Name				

#### Title: Greenhouse Effect And Surface Radiation

**Introduction:** The sun sends Earth radiation in the form of light every day. As it passes through the atmosphere it does not react with the molecules in the air. Light must first strike the surface and change to heat waves. Some surfaces change light to heat very effectively. You may have experienced this phenomenon in the summer as you attempted to walk barefoot across an asphalt road on a sunny day. Dark asphalt gets very hot! Lighter colored cement is much cooler. As the heat waves enter the air, molecules of water, methane and CO<sub>2</sub> have the ability to slow down heat waves that might escape and reflects them back to Earth. Because of this property, Earth's atmosphere wraps us like a warm blanket. In this experiment you will individually test 2 beakers for the greenhouse effect and as a class, compare surfaces.

#### Materials:

1 large beaker, 1 plate, a substance to place on the bottom (water, sawdust, leaves, dirt, white paper, black paper, aluminum foil, styrofoam, cardboard, carbon dioxide), two thermometers or Intel probes, masking tape, ruler

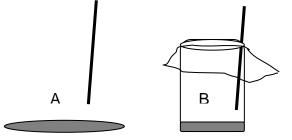
**Hypothesis:** (Which substances do you predict will have the highest and lowest temperatures at the end of the experiment?)

## Identify:

Independent Variables:

Dependent Variable:

#### **Procedures:**



- 1. Place your substance on the bottom of the beaker and plate. You should only have thin layer of the substance. Label them A and B. Beaker B will have plastic wrap over the top.
- 2. Tape your thermometer so that it doesn't touch the bottom or sides of the beaker. You will have to tape the thermometer for A to another object to suspend it over the plate.
- 3. Place your beakers 30 cm from the light source.

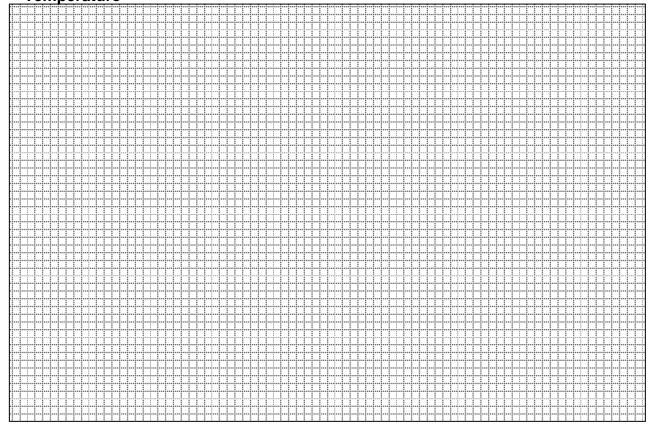
- 4. Take readings of the temperatures for 10 minutes.
- 5. Graph your results.
- 6. Report to the class your highest readings for both A and B and the difference between them. Be prepared to explain why you think your beaker responded the way it did.
- 7. Clean up as directed.

### Data:

**Temperature** 

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Time	Plate A	Beaker B	
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

**Temperature** 



## **Analysis:**

- 1. Which had the highest temperature, the beaker or the plate? Why do you think this was so?
- 2. Which in the class had the highest temperature? Why do you think this was so?
- 3. Which in the class had the lowest temperature? Why do you think this was so?
- 4. Venus has an atmosphere with much more CO<sub>2</sub> than Earth. What would you predict about temperatures on Venus?
- 5. Mars has an atmosphere with less CO<sub>2</sub> than Earth. What would you predict about temperatures on Mars?
- 6. What factors influence the temperature of air?
- 7. Scientists hypothesize that human activities are adding greenhouse gases to Earth's atmosphere that will increase Earth's temperatures. What evidence from this experiment supports this hypothesis?
- 8. The graph shows the relationship between CO<sub>2</sub> and temperature. What are three inferences you can make from this information?

